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(74) Agent: RUSSELL, Vick; 14 Diggers Ave., Gladesville, Sydney, NSW 2001 (AU).

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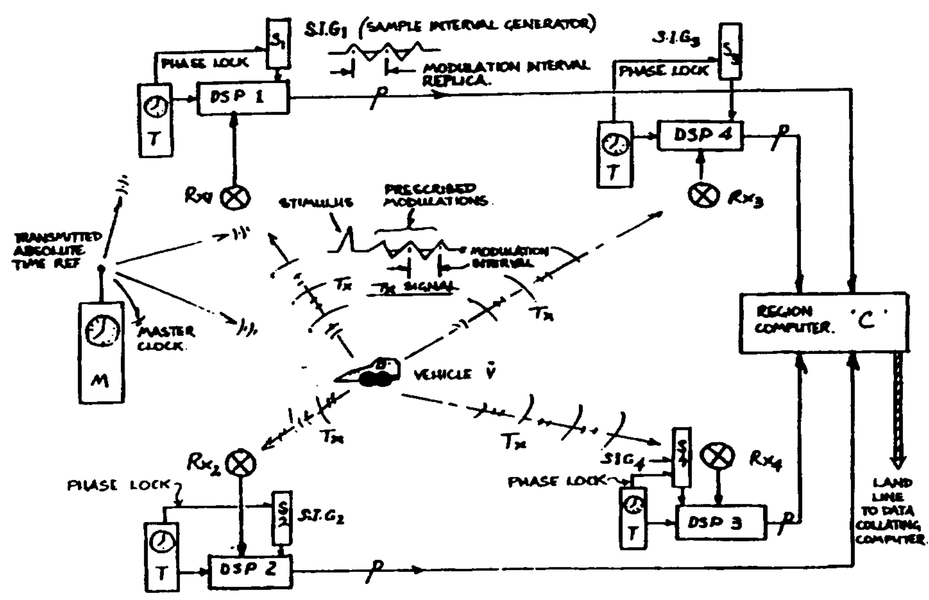
(54) Title: INTEGRAL MODULATION

(57) Abstract



A slope controlled modulation Spread Spectrum TDMA System used in tracking the absolute position of moving targets by radio or other electromagnetic or acoustic radiated energy systems having a master clock (M) transmitting time reference to a network of fixed receivers (RX_1, RX_2...), a mobile transmitter in a vehicle (V) generating a signal (Tx) with a stimulus preceding the prescribed modulation signal. This signal is of incremental and/or decremental time and/or frequency, amplitude, phase or interval modulation domain(s). All the fixed receivers (RX_1, RX_2...) may be normalized to an absolute reference (M) common to all receivers based on propagation time differences between each receiver and the stationary time reference (M). The known relationship of receiver timing differences are used to calculate time of arrival epochs from any mobile transmitter and then substracting these timing differences from the calculated time of arrival epochs from th transmitters. These are then sent to a r gion computer (C) to calculate time of arrival differential f epochs relative to each receiver (RX_1, RX_2...) in order to provide a position fix of the transmitter (V). The transmitter (V) has a facility to produce the stimulus in signal (Tx) as chirp modulation from which the slope controlled m dulation is derived and the receivers (RX_1, RX_2...) having the facility to decode stimulus events.

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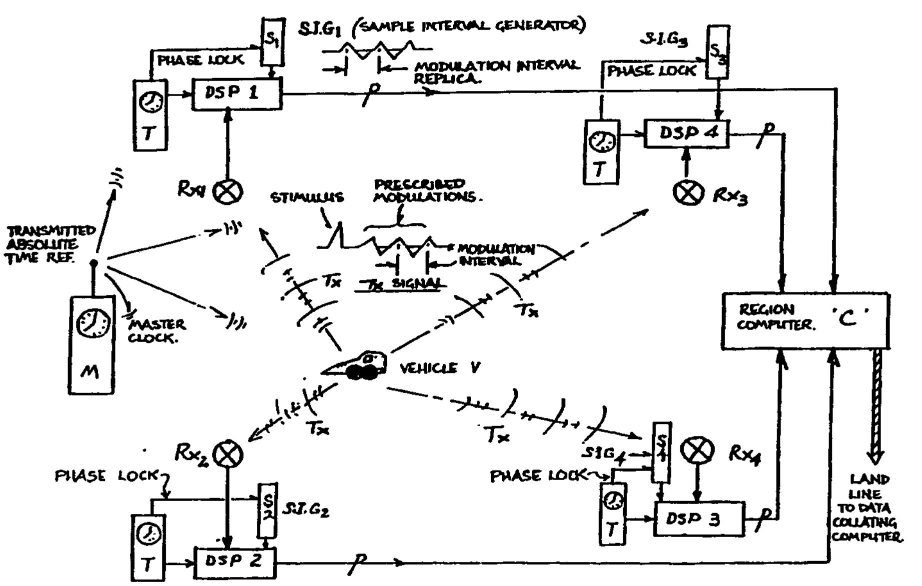

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TITLE OF THE INVENTION - INTEGRAL MODULATION.

THE DESCRIPTION - FIELD OF THE INVENTION.

The invention relates to packet or burst transmission communication systems with spread spectrum and diversity modulation used to allow high degree collision tolerant operation in an asynchronous time division multiple access protocol.

In the preferred embodiment shown in FIGURE 1, the invention also provides Time of Arrival information of a packet transmission in a 'Slope Controlled Modulation' format to a set of fixed receivers so as to allow the asynchronous transmitter position to be calculated.

Slope Controlled Modulation will be described, as will a new method of ordering chirp related carrier frequency profile such that complex prescribed frequency profiles may be anticipated by the receiving electronics thus allowing complement profile processing to increase signal integrity in the presence of multipath/distortion.

Also, a method of data modulation is described which has an ascending or descending continuum, being composed of discrete

ordered steps, the steps belonging to a finite set each with connective modulation property whilst in an ascending or descending chirp carrier modulation; added to this, the ability to generate multiple information carriers by carrier pair generation as set out in diagrams 1 and 2, utilising balanced modulators to produce sum and difference frequency components in these examples from a single radio frequency source and a single or multiple subcarrier source(s) which in the preferred method are frequency agile, which will produce simultaneous up-chirp and down-chirp modulation(s).

Multiple Radio Frequency (R.F) sources with optional balanced modulators (dependant on the data coherence requirement) may be added to permit increased resolution signalling determaination.

The data modulation is variously ordered. The carrier pairs may have in-phase, antiphase or quadriphase data coherence between carriers whilst a plurality of carrier pairs could form such data coherence relations between alternate members in the generated pairs, thus relating carriers of the same frequency direction.

Importantly, in the receiver, complement profile processing would take consideration of the prescribed data modulation ordering for any conceived requirement, this being signalled by a preamble previously described as a stimulus within the priority claim application No. PJ 9704, and so move the slope

controlled (if agile carriers used) local oscillator of the reciever from a frequency midpoint or midpoint offset of that carrier pair in a prescribed slope, adhering to a fixed order once a phase alignment in the data information or carrier has been satisfied, said order being a basic or complex profile that maintains strict adherence to the prescribed modulation directives that have been specified and are immutable for each stimulus or stimulus attribute used within a specific receiver network. Prescribed modulation directives is also understood as 'prescribed directives' found in the priority claim documents within this application, the said application No. PJ 9704.

Within the scope of Integral Detection, being the subject of the said claim documents, the relevant feature is a reduction in the final, or process end point measurement necessity, required to resolve an epoch to a given accuracy. In a method of time base replication, but not synchronisation, between all transmitters (vehicles or trackable targets) and receiver members within a network systemised to provide Time of Arrival (T.O.A.) differentials from compatible transmissions, the number of high resolution measurements necessary to resolve the epoch within a set of periodic epochs, can be reduced to one per epoch period. Even with such a dramatically low sample rate, time domain resolution transmission interval of one millisecond, when said Slope Controlled Modulation protocols are utilised.

The utility of the invention is especially applicable to

tracking the absolute position of moving targets by radio or other electro-magnetic or acoustic radiated energy systems. The encoding may be in terms of incremental and / or decremental vectors, being change in amplitude, time, frequency, phase or interval modulation domain and in any combination of such domains.

Improved information recovery is achieved in any of these domains, alone or in combination, and convertable to distance through time domain processing, either as changes referenced to an external standard, for example an atomic clock, or to an epoch derived from within the system itself, according to criteria established, namely the Modulation Interval replica at the sample interval generated at each receiver. Accuracy and resolution of this measurement system is greater than existing systems using conventional methods or same scale equivalant (number of bits) in terms of dynamic range.

Reduced bandwidth and / or sample rates used in the recovery of the epoch data may be used without the usual compromise in resolution performance when bandwidth or resolution sacrifices are made. A number of features co-exist within the invention, dependent on the nature of signal information and requirements.

System complexity increases with demand for higher accuracy, and so any or all of the succeeding sighted features may need to be incorporated within the more demanding applications. A

transmitter is required which can generate and send prescribed signals of incremental and / or decremental time and / or frequency and / or amplitude and / or phase and / or interval modulation domain(s), this signal here-on synonymous with 'prescribed directives' and 'Slope Controlled Modulation'.

The prescribed characteristics (modulations) should be definable mathematically so as to be reproducable electronically or otherwise able to be estimated at all reciever members of the network, as a recognisable characteristic of the sent modulations prior to actual arrival of said modulations at each receiver. That is, in terms of the receiver, annunciation of the characteristic is required, this being signalled by the stimulus or stimulus attribute as disclosed later in this document.

The transmitter is required to generate a modulation condition prior to sending the profile of the Slope Controlled Modulation, said modulation condition (stimulus or stimulus attribute) possessing unique frequency profile not contained in the Slope Controlled Modulation, hereon referred to as S.C.M.

The S.C.M. [being the prescribed modulation(s)] is forecast at each RX-by an annunciator function. The said function being the stimulus or stimulus attribute as described in Application Number PJ9704. A provisional specification entitled Improvement To Vehicle Tracking Systems lodged in Australia 20th April, 1990 and is included as a priority claim document within this application.

TABLE A

In Relation to diagram 2.

A Dual carrier pair transmitter is depicted in Diagram 2. A free running Continous wave RF source 'A' feeds the RF ports of a pair of balanced modulators 'L' and 'U'. The source frequency is designated (fc) and is gated by the trigger generator 'T' with the resultant (Tgfc).

The output chirp (fi(delta)j) from the prescribed slope generator 'I' in fed to the LO port of modultor 'L'. The resultant DSB output from this modultor consists of sum and difference frequencies:

(Tgfc) - (fi(delta)j) and (Tgfc) + (fi(delta)j).

This carrier pair is designated (Tgfi).

Similarly the prescribed slope generator 'Q' with output (fq(delta(j)) feeds the other balanced modulator 'U' to produce the carrier pair:

(Tgfc) - (fq(delta)j) and (Tgfc) - (fq(delta)j).

This carrier pair is designated (Tgfq).

Thus for a period (Tg) we have a pair of DSB carrier pairs (chirps) offset by the difference between (fQ) and (fI). (delta)j is the instantaneous frequency offset.

The upper sideband components of (Tgfi) and (Tgfq) are designated 'Up'. The lower sideband components are designated 'Lp.'

The two carrier pairs are then combined by hybrid combiner 'H' and amplified by power amplifier 'PA' and subsequently propagated by a suitable antenna.

The prescribed slope generators consists of a pair of VCO's linearised by means of local negitive feedback described in priority claim application number PJ9704 page 11.

The effect of such feedback results in a VCO with a linear transfer function relating the contol port to the output frequency. Note that for this description voltage control is used. Alternate realisations using current control would be equally valid and applicable.

The chirp voltage (cvq) is applied to the control port of 'VCOQ'. (cvq) may be characterised by the following equation:

cvq = gq(delta)j +/- oq.

(gq) and (oq) are constants where (oq) is the the initial

frequency offset voltage and (gq) is the gain (or span). The term (delta)j is the resultant of the prescribed slope function fps(j) at a given instant in time. Typically this function is segmented. For example it could be comprised of an up, down or series of changing slope segments. These are related to the set of prescribed directives associated with a pre-defined stimulus attribute as disclosed in said application PJ9704.

The same prescribed slope function is used to feed 'VCOI'. The variable subscipts may be substituted thus:

cvi = gi(delta)j +/- oi.

where (gi) and (oi) are the gain and offset constants for 'VCOI' respectively.

Although the prescribed slope function for generator 'Q' is identical to generator 'I', the inititial frequency offsets are different.

In order to effect coherent carrier detection descriped elsewhere in this document there will usually be an integral relationship between fq (j=0) and fi (j=0), (the initial frequencies). In clarification fq = n(fi), where n is an integer.

The prescribed slope function impressed on and common to the

'I' and 'Q' VCO's is known as the 'major face'. This is the primary frequency agile component of the modulation system embodied by the system. The terms 'Major face' and 'chirp' are synonymous.

Generation of the 'Major face' is triggered by the Trigger Generator 'TG'.

Sub-chirp or 'Minor face' data modulation is impressed on the 'major face' prescribed slope by means of the Sub-Chirp Generator 'SCG.

In relation to Diagram 5.

A receiver is shown capable of translating two pairs of data carriers 'Up' and 'Lp' produced by the transmitter described above. The stimulus attribute is not shown but is assumed present. The stimulus is generated in an offset frequency, coherent data pair x and y.

The said carriers being generated by a similar circuit configuration as in Diagram 2, with said data coherence being represented by SCM (theta)i and SCM (theta)q. The said offset being represented by (Voi) and (Voq). Related to Diagram 5 the frequency translaters up convert accurate 'VCOL' and 'VCOU'. Each of which hold a prescribed relationship once the trigger generator 'TG' is satisfied of a reliable chirp detection.

The said chirp detection process consists of a Disperal Delay Line with an inverse dispersion characteristic to the expected stimulus attribute to provide a compressive reciever function. The bandpass filters pass the data modulation components at the stable IF frequency shown as two pairs of 30 MHz and 40 MHz as shown in Diagram 5. Product detectors are able to carry out synchronous demodulation of each individual carrier SCM component with a locally generated reference, providing a unique relationship in that the said reference is not recovered from the incoming signal as in prior art for synchronous demodulation.

Instead synchronisation is achieved by means of a frequency / phase lock control loop which acts to establish a relationship between the phase of the said VCO's and incoming carrier pair IF products via the allignment processor. The said allignment being established and reinforced by the diversity properties of the variously ordered frequencies being non-coincident to multipath distortion. This permits majority voting of phase allignment to establish a definite hold function to the phase allignment process as output from the 'FPA' in Diagram 5.

The data outputs A, !A, B, !B relate to the phase relationship of the data as described by the original transmission and are used to further control future requirements. Note that A, !A, B, !B can also be in quadrature rather than the antiphase depiction, that is A = 0 degrees, and !A = plus or minus 90 degrees.

In relation to Diagram 4.

Diagram 4 chows a more basic receiver operating with a non-offset carrier pair transmission signal.

The communications system utilising a variety of novel agile techniques (exampled within this application) to reach performance levels in the delivery and reception of information, also providing a multiple access advantage in a system demanding multiple user access.

Radio ranging is provided by a data ordering method of ascending or descending modulation continuum with connective property permitting epoch reinforcement method based on the associated carrier pair phase relation of data. Specific codes to be used to produce Time of Arrival (T.O.A.) differences between incoming information and reference information as intercepted in a surface or bulk acoustic wave convolver or digital correlator (as described in this disclosure) with emphasis on square wave interaction or digital decoded

information, due to the nature of the convolution of square (or rectangular) waves producing a triangular product which enhances the method of Integral Detection to resolve epoch detection as described later in this disclosure. The Integral Detector is subject of a disclosure, number PJ9527 a provisional specification lodged in Australia 6th April 1990 and is included as a priority claim document within this application.

In the preferred method, each data packet (the minimum discrete quantity of data) is represented by two sub-chirps, being the shortest frequency excursions within the major modulation, composed of an ascending or descending triangular step or any discrete alternative modulation pair, capable of producing an m-ray vector decision at the receiver which can represent up to 4 bits of data in our preferred method, and 8 data bits in ideal situations.

The sub-chirp duration preferably is below ten microseconds, the end point from which another follows until the entire S.C.M. is completed. The sub-chirps are of a finite data set, composed from a set of apex extremities forming an m-ary decision constellation around the perimeter of the sub-chirp pair field, said fild being the sub-chirp duration interval and the assigned modulation vectors within that interval. This is shown and explained by Example S.

entire Slope Controlled Modulation is composed of
ie said sub-chirp pairs, with the ultimate
file of each Major Face depending on the dv/dt
olarity (direction) of the prescribed slope
he slope controller may be prescribed a set of
les to achieve collision tolerance within a
vironment by virtue of regulated progressive
jor Face slope, quite independent of the sub-chirp

e profile(s), modulated with a series of said
rs, each having linear or digital modulation
eing said modulation vectors, and belong to a
d set. The said ordered finite set has a property
equate signal processing facility can be equalised
omain so that a single vector can be synthesised
he set by a process parallel to pr-emphasis/
r reverse order comanding techniques. This allows
terval a property where a digitised result of any
y be referenced (re-normalised) to an absolute
al point. The said re-normalising function is also
th analog techniques such as Instantaneous
rrection.

of the abovementioned sub-chirp pair or optionally
ment is made equal to a Sample Interval. A Sample
Modulation Interval Replica) is made equal to
n interval as generated by all target transmitters

by selecting close tolerance or equal crystal frequencies to provide the defined sub-chirp pair or sub-chirp element interval period.

By virtue of the fact that the Major Face frequency profile is prescribed for various application specific signal sets and that any of the set can be anticipated at the receiver by use of stimulus or stimulus attribute signalling as described later in this document, synchronisation may be carried out. This allows the carrier pair sub-chirp content to be closely followed by control process defined within Table A by established prescribed slope sample and hold techniques as outline in Table A.

To effectively measure each epoch's T.O.A. , as well as to enable the definition of each sub-chirp slope, (and therefore the data contained within the sub-chirp interval) a number of surface or bulk wave devices (convolver, correlator or dispersive filter) or digital correlator operation as described further on, will be used in a parallel process with each property matching the essential function necessary to extract the information required. Alternatively digital profiling may be used, as outlined in the following four examples:

1. Serial processing with a shift register correlator.

2. Parallel digital correlation with a confidence level output

reflecting the degree of proximity matching to a finite code set.

3. Analogue to digital flash conversion techniques to carry out profiling, D.F.T, average and mathematical correlation processing to resolve the epoch.

4. The use of Integral Detection by the said method elsewhere in this disclosure and referenced to said priority claim PJ9527.

Epoch timing errors are available as an integration or convolution of timing difference between the T.O.A. of the information at the signal port and the known timing reference of the reference signal, said reference being locked to the Sample Interval at each receiver. The convolvers used will have an interaction time of 2Tm with the reference signal launched every 2Tm intervals at time 0Tm, 2Tm, 4Tm, with a duration of approximately Tm, being Tx , to intercept a signal of duration Tx with virtually 100 percent probability.

Problems are encountered when many users attemp to access a single service where competition could cause information loss due to transmission collision. It is the systems primary objective to accomodate multiple users with less incidence of destructive collision compared to any previously used methods. One outstanding property offered by this invention is near 100% collision tolerance within a asynchronous multiple

access signalling protocol.

The methods encompass a number of modulation schemes, set out below, that will enable superior recovery of the S.C.M., being analog or digital data impressed on a plurality of carriers. An accurately defined frequency band is utilised for each carrier pair, this band being static or dynamic, for fixed or agile frequency method respectively.

A reinforcement of data detection may be achieved in the demodulation process when the carrier modulation components of each pair can be made relational by mixing each carrier or the carrier pair, with an equidistant or offset from the midpoint of carrier pair frequency distance, with a local oscillator frequency so as to result in one or more simultaneous, static Intermediate Frequency products able to maintain the resulting I.F. carrier pair data modulation components or carrier pair coherence synchronous, and by novel example whereby this is achieved for carrier coherence whilst actually holding the I.F. relation at f0 (for the first I.F. member) and 2f0 (for the second I.F. member):

This said frequency separation, being a 1 : 2 ratio, is necessary when carrier coherence is required for biphase demodulation as shown in Diagram 3, where the first I.F. is passed through a squaring element E to remove the biphase modulation and also

to double the carrier frequency, thus restoring coherence with the second I.F (restoring frequency equality) exluding the phase modulation which enables information demodulation when both said carriers are passed through the balanced mixer M.

Diagram 3 depicts detail of the upper chirp set, with the lower chirp set process in assumed form (hidden detail) inside the box labeled ' Lower Chirp Set' which virtually duplicates the upper set though obviously utilises a down chirp slope.

A parallel digital correlator is exemplified working with each demodulated data output. The said correlators could be merged into a single unit by expanding the state machine function into a two port data input device with common or dual correlation reference channel(s) serving to program the device. The said correlator reference code could be programmable at a given chip rate to provide a code agile correlation function.

The programmable reference code chip rate would allow at least one data clock period comparison time to occur, given the data ripple time requirement is satisfied. The said data ripple time is the number of clock periods that are required to align an m - depth parallel data word (usually a signal) sequence to a requisite position within the memory array depth of the correlator, the said position producing adequate results from the n-bit output port.

In the preferred method, as signals to be correlated are time sequenced, a high speed parallel shift register is used to implement the memory array.

For special code sequences it is preferable to have random access to the reference or data content in the memory array to resolve for such events as lost data, (such as in poor signal to noise ratio information conditions) the reference or data code bit change based on the confidence level based on the n-bit binary output product result from the current correlation process. The said code resolving process can be made dependent on specific data replacements based on the change of the n-bit binary output from the correlator .

A plurality of digital outputs is available from each correlator, producing an n-bit binary number reflecting confidence level of code match, with an ordered relation, based on data code versus reference code proximity factors. The said proximity factors being programmable according to previous definitions, to modify (change or optimise) the correlation proximity output product, thus modifying the n-bit binary number output.

Diagram B shows a four bit output, being dependent on the correlation function programmed within each of the two parallel

correlators and the profile match of an 8 bit wide, y - depth signal data word within a Z - depth programmed reference code in a memory array. The said reference code being programmable to provide a code agile correlation funciton. Alternatively, the data content (derived from a digitised input signal) is modified to provide a function that will compensate for data errors to yield improved correlation speed in cases of uncertainty.

In combination with the above :

[A] Initial Synchronising to achieve precise relation to the Major Face frequency profile of two data synchronised carrier pairs Clearly this will maintain data coherence as the carriers are demodulated.

[B] Initial Synchronising to enable the control loop to keep the resulting I.F. carrier pair synchronous, or coherent, if by frequency translation, the said carrier pair has frequency parity.

[C] As in [A] or [B] though utilising the diversity of the original carrier frequencies (of the pair) to suppress multipath components based on the well known frequency dependent characteristics of multipath. This is achieved by either selecting the more coherent intermediate frequency carrier of the carrier pair, or multiple such carriers from a plurality of carrier pairs, when in the general sense

only one member from any pair will suffer from multipath signal distortion. Majority voting is then used to determine satisfactory Initial Synchronisation alignment, after which a strictly prescribed slope of frequency profile (the Major Face profile) is adhered to. The control loop has an option in the preferred method of being disabled from the advance / delay control of the Voltage Controlled Oscillator, (here-on termed V.C.O.) output phase, said V.C.O. derived from correlation peak or phase and/or frequency satisfaction of the data modulation or carrier coherence modulation of specified combination of carrier pairs.

The Intermediate Frequency (I.F.) components are the result of mixing a data related carrier pair with a local oscillator placed at a midpoint frequency or midpoint offset of the instantaneous centre frequency between said carrier pairs, essentially keeping either relation during the course of the packet or burst duration. This produces two related I.F. components, in the preferred method stable components able to interact to produce a number of property dependent results :

A) Passage through a common narrow band filter.

B) Demodulation of information contained within the carrier pair if in quadriphase or biphase and processed by a phase sensitive network.

C) The preferred transmit interval, being less than 10 milliseconds, is resistant to doppler analysis, except for multiple pairs, this is because doppler will not manifest over said short interval except by the difference at two spaced frequencies. The utility of this property when the spacing is substantial and multiple pairs are processed for said relational doppler properties.

D) Choice of common or isolated I.F. outputs , with near or far frequency distance with specified number of carrier pairs - by simple sum and difference relation of any number of fixed frequency radio frequency (R.F.) resonators when mixed with specified number of swept oscillators with select start /stop frequencies each producing a mirror image or inversion of frequency direction (opposite sense chirp modulation) for the duration and span of swept components, said components being the S.C.M. set.

When full agile principles are utilised, the system operates in a slope controlled burst mode, where the frequency agility is a function of the slope control of that quantity, or rate of change of the carrier pair frequency referred to an event such as a stimulus or stimulus attribute as described elsewhere here.

In example, the simplest configuration is shown in diagram 5

where a radio frequency oscillator source A is used as a carrier input to a Double Sideband or Balanced Modulator B, which produces two carriers G and H each having a frequency agile slope of 4 MHz accomplished in time T, this being the burst or packet duration, known as the S.C.M.

A preamble, the stimulus signal, is triggered by a timing circuit (the stimulus trigger generator). This sequentially triggers the Prescribed Slope Generator and gates the V.C.O. and data generator (sub-chirp generator) in order to produce the stimulus and S.C.M. in sequence from a prescribed slope generator (P.S.G.) consisting of a read only memory (R.O.M.) driven digital to analog converter (D.A.C.), said D.A.C. controlling the V.C.O. output.

Voltage Control Oscillator (VCO) C generates the frequency modulation necessary to achieve a carrier pair output from basic sum and diffence product output of a balanced modulator when fed into the signal modulation port of B.

The modulator input can be a high level switching function causing harmonic output at multiples of the instantaneous modulating frequency from C. The trigger generater E signals the modulation event by allowing a prescribed dv/dt (slope) voltage function from said prescribed slope generator D to control the VCO frequency at C.

Data can be impressed on the modulation via a phase shift element F before being combined with the carrier frequency A to form the agile carrier pair G and H, both carrying synchronous phase coded data. Clearly, element F may be a biphase, or Frequency Shift Keyed (F.S.K.) device for binary data.

Alternatively, the V.C.O. 'C' may be modulated with analog or digital data to superimpose the data as an added Frequency Modulated (F.M) subcarrier to the chirp modulation profile. Other variations of slope controlled modulation methods are given further-on.

This is an application of the vehicle tracking system dealing with the problem of identifying and immobilising a vehicle whose status by its signal output can be electronically identified as stolen or unauthorised. That is, the described application can be deployed for the purpose of remotely or automatically stopping a vehicle that has entered an unauthorised area, or preventing the continued passage of a vehicle after establishing illegal occupation of the vehicle such that there is a reasonably accurate knowledge of its position when it stops.

This device is also described as a conditional signalling protocol designed for the detection, immobilisation and position reporting of stolen vehicles. Several arrangements of the device exist. A radio transmitter mounted within the vehicle has the ability to produce identifiable signals capable

of being received, these being triggered by and continued from unauthorised vehicle entry.

The vehicle also has a radio receiver capable of immobilising said vehicle when instructed from a fixed or mobile security transmitter, said transmitter being alerted by the proximity of said stolen vehicle alarm transmission. The said alarm transmission carries identity information of said stolen vehicle so that visual confirmation may be established prior to manual signalling to immobilise said stolen vehicle. The security transmitter has the facility to be signalled by a companion reciever which is activated by the stimulus attribute of the said vehicle transmission, said transmission also conveying identity information within the prescribed Slope Controlled Modulation.

In the case of a fixed security transmitter installation the co-operation of four transmitters in a similar arrangement to figure 1, with the ability for the region computer to decide when the vehicle 'immobilise signal' will be sent, based on either signal strength or geographical location of said vehicle. An alternative configuration offering the ability to track any stolen vehicle outside a square cell defined by the perimeters of the four receivers by external triangulation methods with differential T.O.A. calculations providing a position fix. The utility of the above mentioned stolen vehicle identification and/or status reporting (such as speed

logging) of prescribed users, being compatible with the signalling protocols as disclosed within this application.

CLAIMS -

The claims defining the invention are as follows :

Claim 1.

A slope controlled modulation spread spectrum asynchronous time division multiple access system comprising: An absolute time reference or master clock transmitting time reference to a network of fixed receiver sites.

A method to receive said time reference at each receiver site with facility to normalise said absolute time reference within all fixed receivers belonging to a network, based on propagation time differences between each of the receiver members and the stationary said time reference.

The said known relationship of receiver timing differences being used to calculate Time Of Arrival epochs, being corrected for receiver position, from any roaming transmitter in the range of the cell mapped in a region computer, for the associated receiver members, said members land line connected

to convey Time Of Arrival epochs to said region computer.

A method to phase lock each Sample Interval Generator of each receiver member of a network to said receiver normalised time derived from said absolute time reference.

A method to subtract said timing difference fom required receivers within the network, from calculation Time of Arrival epochs arriving from said transmitters.

A method for each region computer to calculate T.O.A. differentials of epochs sent by said transmitter, relative to each other said receiver members in order to provide a position fix of said transmitter.

A method to include data information within said transmitter modulation.

A method to include said data information recovery at each said receiver member of each said region computer within signal strength range qualification of said transmission

A method to convey positition and data information recovered at each region computer via land lines to central computer for despatch.

CLAIM 2

In a mobile transmitter, the facility to produce the stimulus as a unique chirp modulation which relates to a specific prescribed modulation, resulting in a Slope Controlled Modulation output after the expiry of said stimulus.

Said prescribed is desfined as an ordered modulation set composing the major face profiles of the transmitted set of modulation intervals comprising the message.

CLAIM 3

In all receiver members of a network of fixed receivers intended for the purpose of distance measurement and / or communication the facility to decode stimulus events composed of stimulus attributes being unique within the message.

CLAIM 4

For a receiver network as in CLAIM 3 the ability of said receivers to accurately time align a prescribed slope generator trigger, based on the established epoch of the stimulus so as to anticipate the time of arrival of the starting point of the modulation interval set, said interval set being the slope controlled modulation.

Said starting point to signal the prescribed slope generator to follow the major face profile content of the message.

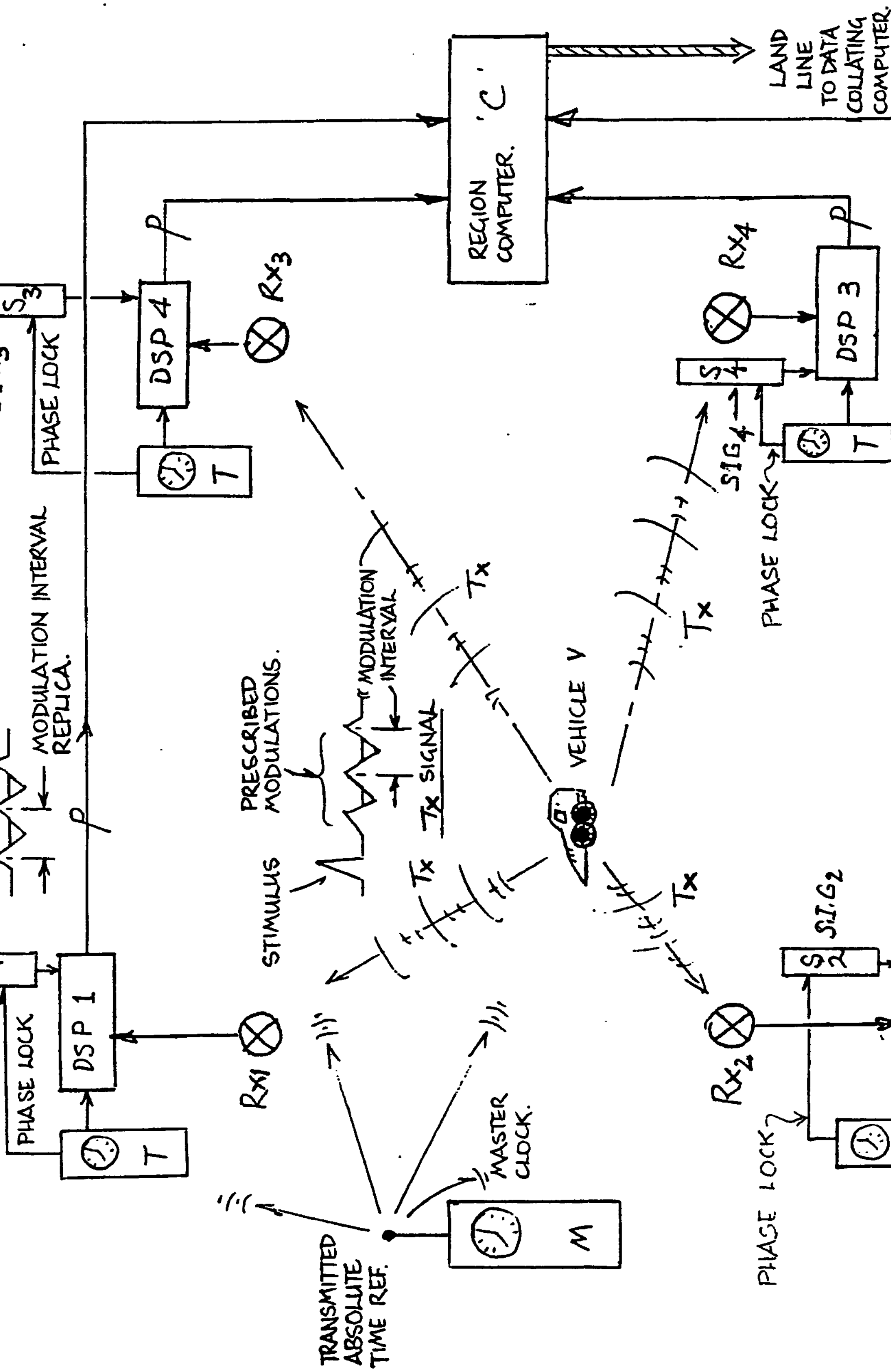

FIGURE 1

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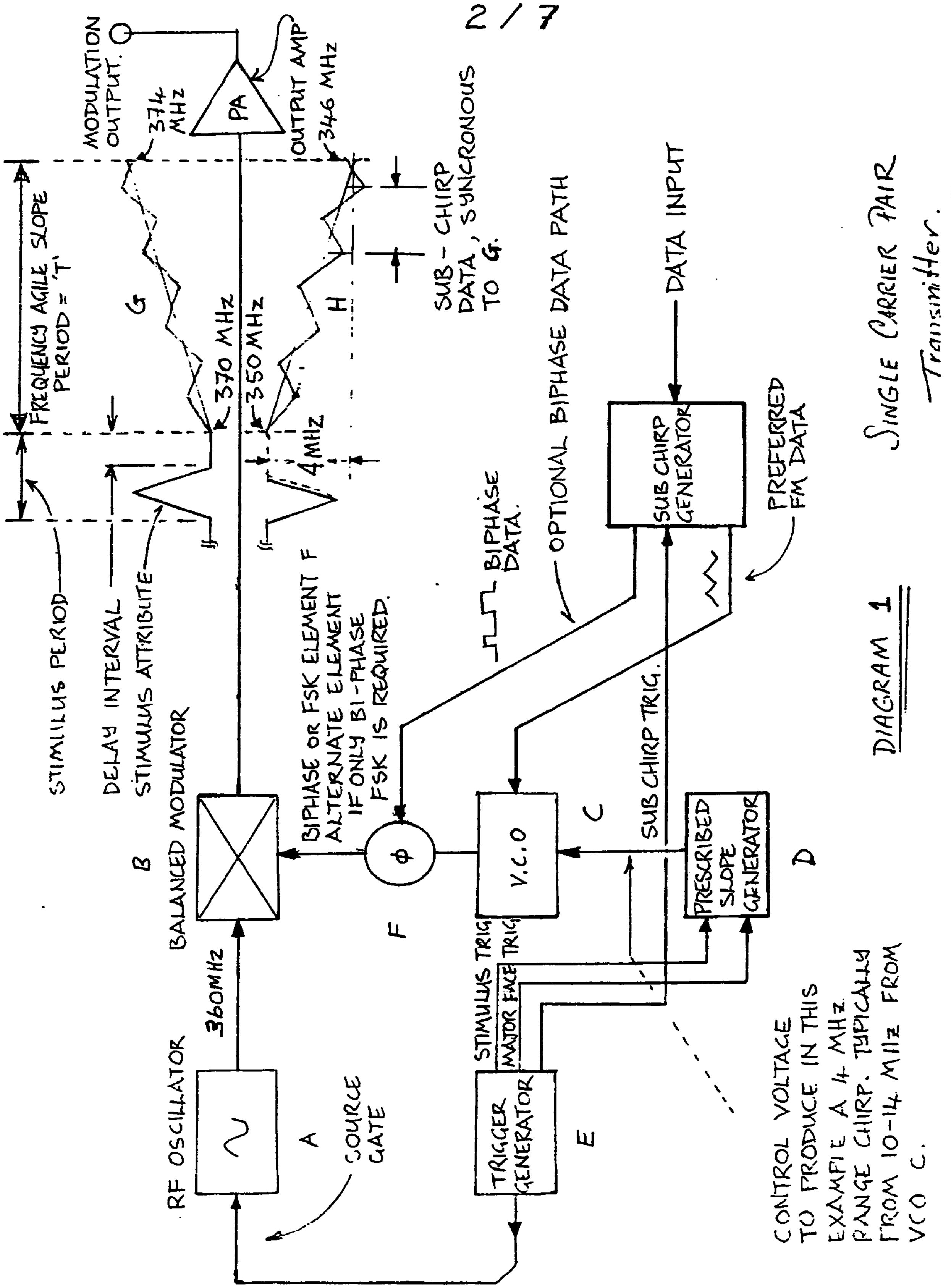

DIAGRAM 1

Single Carrier Pair Transmitter.

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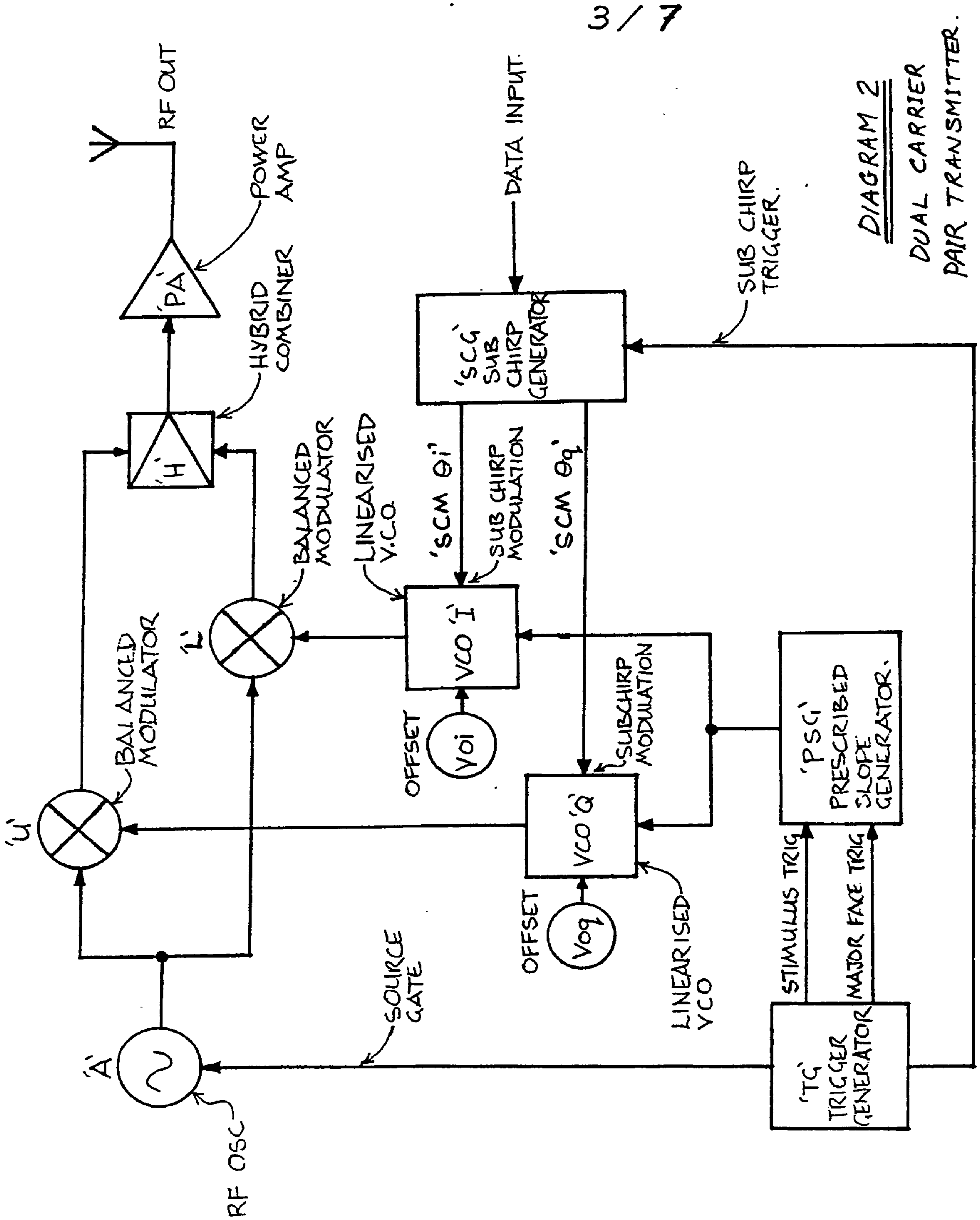

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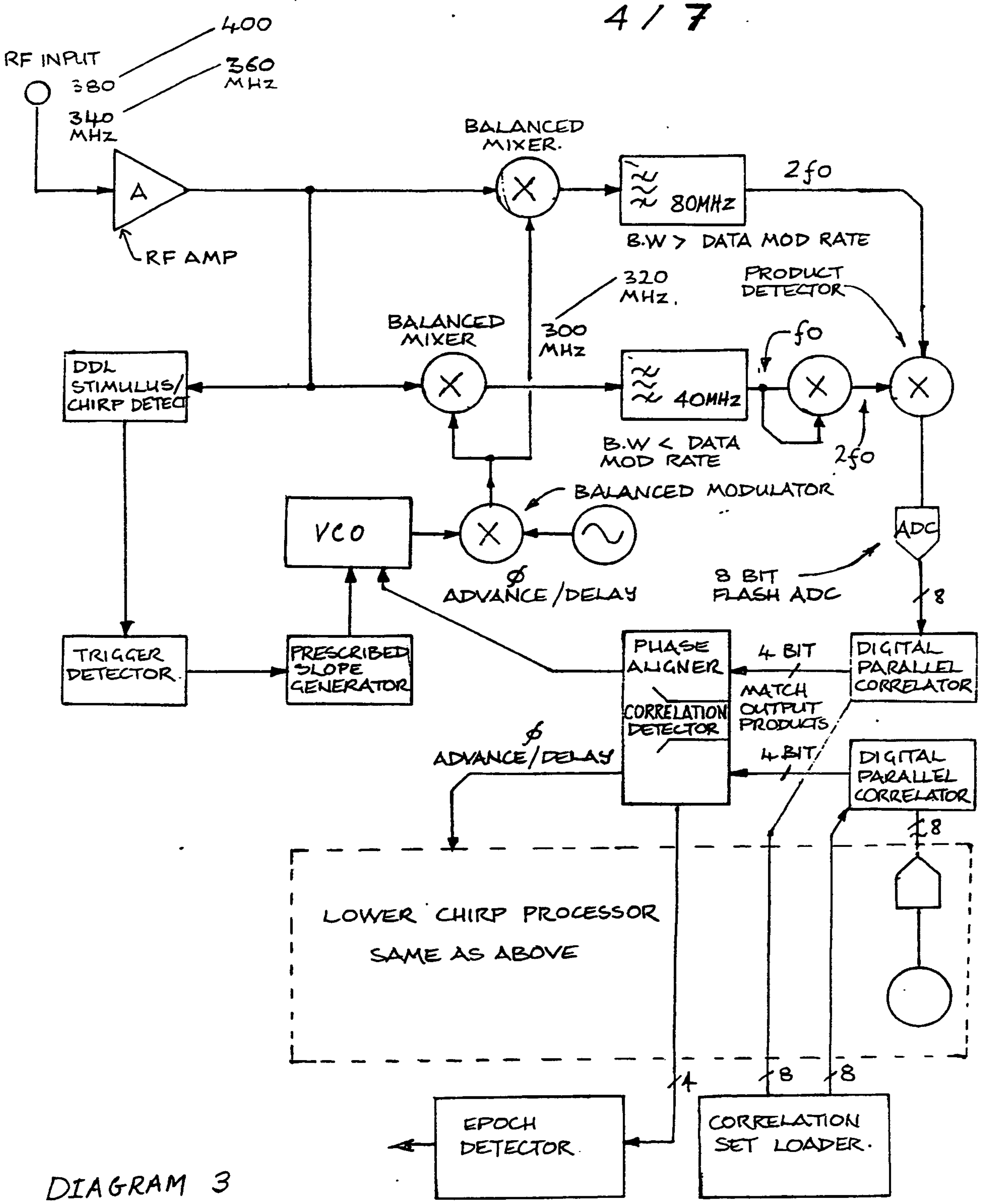

DIAGRAM 3

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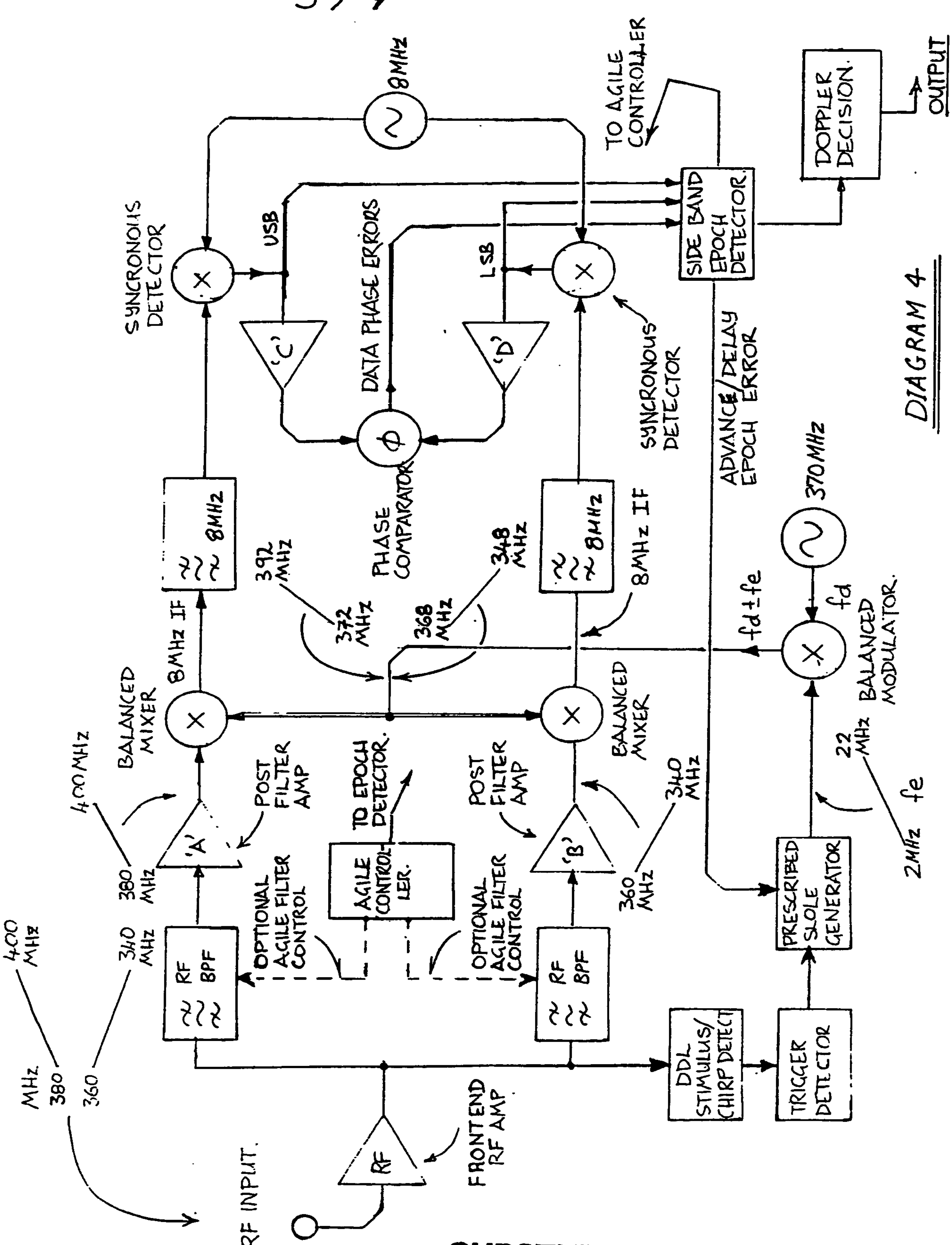

DIAGRAM 4

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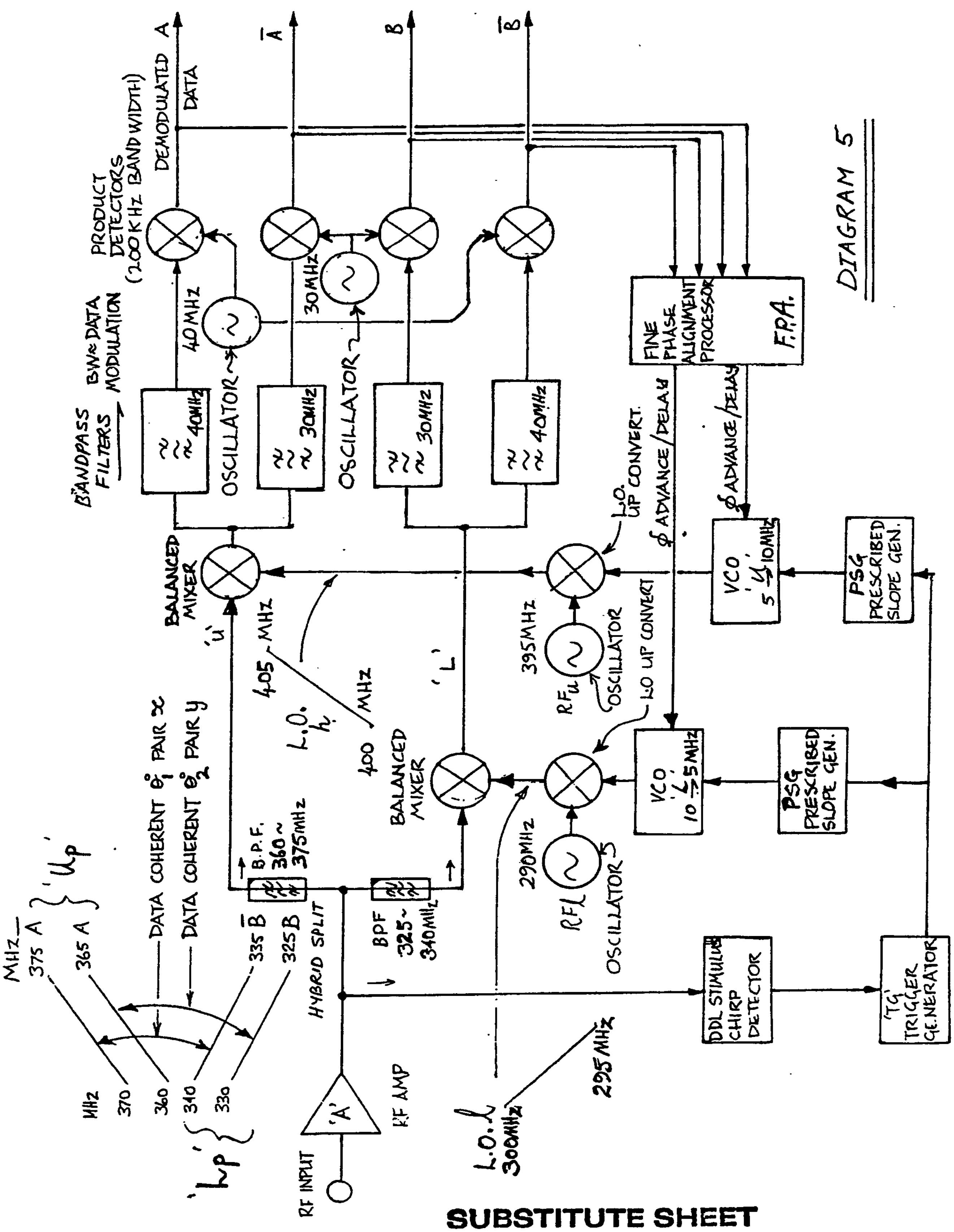

DIAGRAM 5

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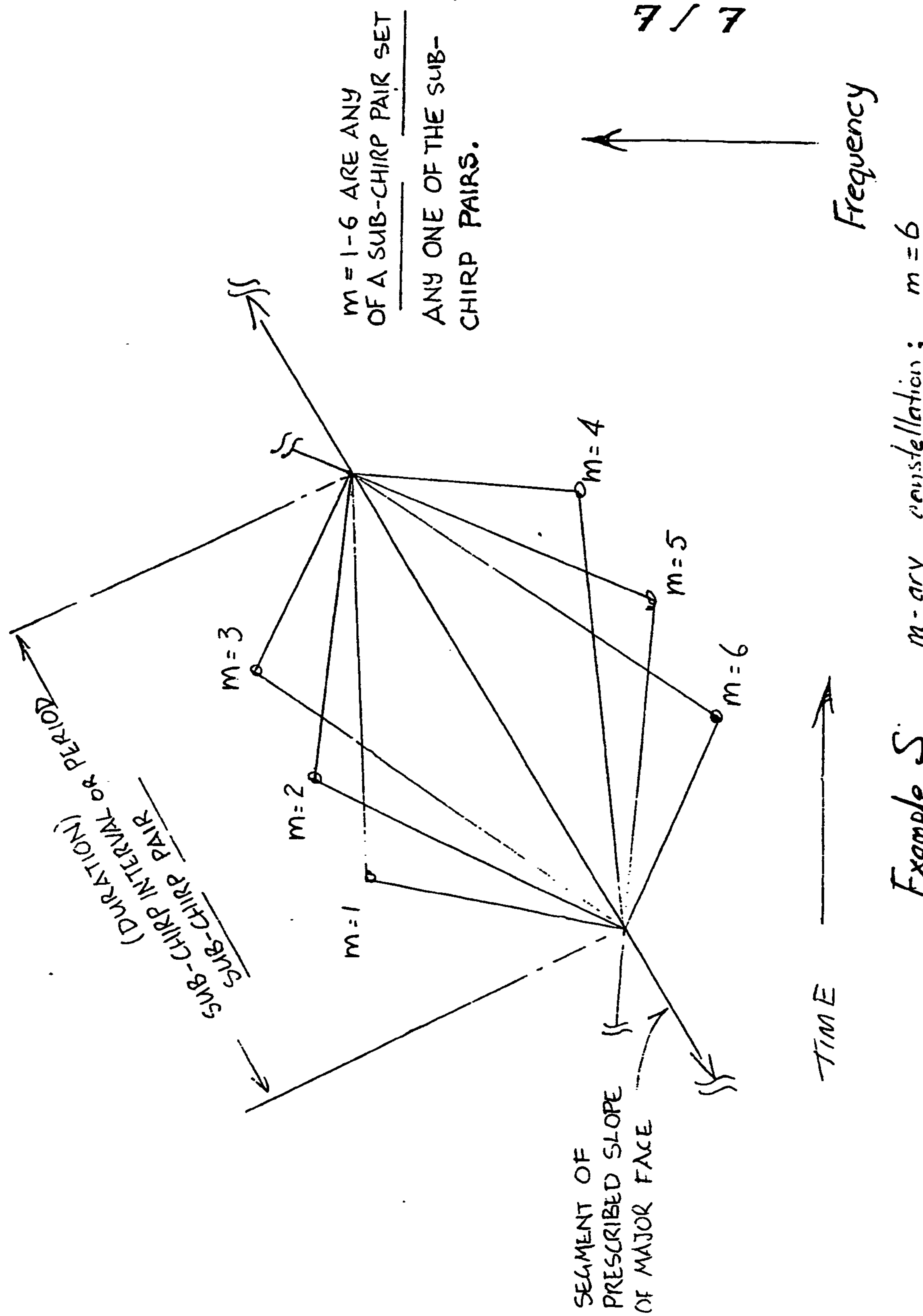

SUBSTITUTE SHEET

INTERNATIONAL SEARCH REPORT

International Application No. PCT/AU 91/00102

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicat all) 6

According to International Patent Classification (IPC) or to both National Classification and IPC

Int. Cl.[5] G01S 5/06

II. FIELDS SEARCHED

Minimum Documentation Searched 7

Classification System	Classification Symbols
IPC	G01S 5/06, H04B 7/26, H04Q 7/04

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched 8

AU : IPC as above; Australian Classification 05.50

III. DOCUMENTS CONSIDERED TO BE RELEVANT 9

Category*	Citation of Document, 11 with indication, where appropriate, of the relevant passages 12	Relevant to Claim No 13
X	US,A, 4812852 (BENT et al) 14 March 1989 (14.03.89) See Column 2 line 47 - Column 2 line 57	(3)
A	See abstract	
X	WO,A, 87/04883 (ADVANCED SYSTEMS RESEARCH PTY LTD) 13 August 1987 (13.08.87) See page 1 line 1 to Page 20 line 6	(3)
X	US,A, 4152651 (LAMPERT et al) 1 May 1979 (01.05.79) See Column 1 line 6 - Column 8 line 50	(3)
A	As above	
X	US,A, 3848254 (DREBINGER et al) 12 November 1974 (12.11.74) See Column 4 line 4 - Column 5 line 19	(3)
A	See abstract	

(continued)

* Special categories of cited documents: 10

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
28 June 1991 (28.06.91)	4 July 1991
International Searching Authority	**Signature of Authorized Officer**
Australian Patent Office	a.W. Duke A.W. DUKE

Form PCT/ISA/210 (s cond sheet) (January 1985)

FURTHER INFORMATION CONTINUED FROM THE SECOND SHEET

X	US,A, 3419865 (CHISHOLM) 31 December 1968 (31.12.68) See Column 9 line 9 - Column 9 line 16	(3)
A	See abstract	
A,P	AU,A, 28649/89 (SCIENTIFIC DEVELOPMENT, INC) 26 July 1990 (26.07.90) See Page 1A - Page 39	
A	AU,B, 22999/88 (599552) (NEC CORPORATION) 6 April 1989 (06.04.89) See Page 1A - Page 24	
A	US,A, 3995273 (ULSTAD) 30 November 1976 (30.11.76) See abstract	

V. [ ] OBSERVATIONS WHERE CERTAIN CLAIMS WERE FOUND UNSEARCHABLE 1

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1.[ ] Claim numbers ..., because they relate to subject matter not required to be searched by this Authority, namely:

2.[ ] Claim numbers , because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3.[ ] Claim numbers ..., because they are dependent claims and are not drafted in accordance with the second and third sentences of PCT Rule 6.4 (a):

VI. [ ] OBSERVATIONS WHERE UNITY OF INVENTION IS LACKING 2

This International Searching Authority found multiple inventions in this international application as follows:

1.[ ] As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims of the international application.

2.[ ] As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims of the international application for which fees were paid, specifically claims:

3.[ ] No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claim numbers:

4. [ ] As all searchable claims could be searched without effort justifying an additional fee, the International Searching Authority did not invite payment of any additional fee.

Remark on Protest

[ ] The additional search fees were accompanied by applicant's protest.

[ ] No protest accompanied th payment of additional search fe s.

ANNEX TO THE INTERNATIONAL SEARCH REPORT ON INTERNATIONAL APPLICATION NO. PCT/AU 91/00102

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report	Patent Family Members					
US 4812852	US	4916455				
WO 8704883	AU	582038	EP	292487		
US 4152651	CA	1056966	FR	2372551	GB	1502254
	IT	1019516	NL	155691		
US 3848254	AT	330845	CH	539856	DE	2137846
	FR	2148089	GB	1362343	IT	963373
	NL	7210127				
AU 22999/88	EP	310939	JP	1088273	US	4879713